Evaluation of the Effect of Water Quality Degradation and Iron Oxide Precipitation on the Benthic Macroinvertebrate Community Downstream of F.E. Walter Reservoir

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Introduction

The following report documents the results of the 14 August 2002 benthic macroinvertebrate sampling effort conducted at three sites on the Lehigh River. The investigators were Leroy Young and Ted Bukowski of the Pennsylvania Fish and Boat Commission and Greg Wacik of the U.S. Army Corps of Engineers. This study was done to document the response of the benthic macroinvertebrate community to significant precipitation of iron oxide and elevated H_2S levels in the discharge of F.E. Walter Reservoir that resulted after pool levels were increased in 2002. F.E. Walter's normal non-flood pool elevation is 1300 ft (NGVD). As the result of a DRBC declared drought emergency in 2002, DRBC requested the Corps of Engineers to store 12 billion gallons for drought relief. This resulted in a pool level of 1392 NGVD. At the time of this sampling the pool level was 1377 ft NGVD, or 15 ft lower than the maximum elevation attained in 2002. A COE study in the reservoir at the same time as our survey indicated that the top of a well-defined thermocline was located at about 1370 ft NGVD and that the water was essentially anoxic below that point. Water quality samples from sites between the dam and the PA Turnpike bridge on 13 August 2002 documented S^{-2} levels ranging from 0.009 - 0.047 mg/l, total Fe levels from 0.58-0.88 mg/l, Mn levels from 0.01-0.88 mg/l, dissolved oxygen from 8.66-8.72 mg/l, pH from 6.35-6.41 mg/l, conductivity of 0.068 mS/cm and H_2S ranging from 0.003-0.047 mg/l (U.S Army Corps of Engineers data, Ashby 2002). Strong H_2S odors were evident downstream of the dam.

Methods

We sampled benthic macroinvertebrates at three sites (Figure 1, Table 1). Site LR01 was located upstream of the reservoir at the first riffle downstream of the Tobyhanna Creek confluence. Site LR02 was located approximately 0.8 miles downstream of the dam at the first riffle downstream of the USGS gage. Site LR03 was located about 1.3 miles further downstream at the first riffle downstream of the mouth of Pine Run. These are three of the same sites that were sampled in 1998 and 1999 during an investigation of the impacts of white water releases from the reservoir on the downstream biota (Reynolds and Young 2000). At each site we collected six Surber net samples. Samples were preserved in the field in isopropyl alcohol, and then returned to the laboratory for sorting and identification. All organisms were counted and identified to genus, except for several taxa that were identified at higher taxonomic levels. A suite of metrics, most of which are described by Barbour et al. (1999), were calculated for each sample. We used the same suite of metrics routinely computed by the Pennsylvania Department of Environmental Protection in their "Unassessed Waters" stream sampling program.

Results and Discussion

The results of the RBP habitat analysis are documented in Table 2. Habitat scores were excellent at all sites, ranging from 177 to 196 out of a total possible score of 200. These scores would all be characterized as "optimal" according the scoring convention of Barbour et al. (1999). Site LR02 had the lowest score of 177. This was the result of a very low score for "embeddedness" which was largely the result of the heavy iron flocculent that covered the

substrate. Iron flocculent was also observed at LR03, but at a much lower level.

Tables 3-5 document the results of the benthic macroinvertebrate sampling. Twenty-eight taxa were collected at LR01 compared to 18 and 26 taxa at LR02 and LR03, respectively. The number of individuals collected at the three sites was 492 at LR01, 248 at LR02, and 662 at LR03. While numerous taxa comprised a significant proportion at the sample at LR01 (e.g., *Cheumatopsyche, Stenonema, Epeorus, Baetis, Neureclipsis*, chironomids), the samples at LR02 and LR03 were comprised primarily of chironomids. Generally the RBP metrics indicated a depressed community at LR02 compared to the upstream site (LR01)(Table 6). LR02 had the highest Hilsenhoff index, lowest number of taxa from the environmentally sensitive orders Ephemeroptera, Plecoptera, and Trichoptera (EPT), the lowest percent of EPT individuals, the highest percent dominant score, and the lowest Shannon Diversity score. In all cases these would be the predicted responses for increased perturbation at a site. The site also had the lowest number of tolerant taxa, which typically would suggest less perturbation than at the other sites. However, in this case it was simply the result of a depressed number of total taxa at LR02. Site LR03 demonstrated scores intermediate to those at LR01 and LR02 in most cases, indicating that recovery was occurring at this site. However, both downstream sites received poorer scores than those at LR01 for most metrics. In some cases these changes were drastic (e.g., percent EPT, percent Dominant, and Shannon Diversity).

Table 6 and Figures 2-11 provide a comparison of the 2002 results with those from samples collected in 1998 and 1999 (Reynolds and Young 2000). In that study we documented declines in quality of the benthic macroinvertebrate community downstream of the dam, but the changes could not be linked to white water release events. In the current study we are not as much interested in the change from above the reservoir to below as we are to the relative changes in the fauna that have occurred since the pool levels were raised, the iron oxide deposits were observed downstream of the dam, and elevated H_2S levels were detected. Several metrics from the current study indicate benthic macroinvertebrate changes downstream of the dam that were indicative of perturbation and much greater than the changes that were observed in comparison to the upstream site in 1998 and 1999. For example, the Hilsenhoff index scores, which typically increase with increasing perturbation, were higher at LR02 and LR03 in the current study than in any previous sample at those sites, as well as higher than at LR01 this year (Table 6, Figure 4). The EPT scores at LR02 were lower in 2002 than at any time in 1998 and 1999. Conversely, the scores at LR03 were slightly higher than those observed in 1998 and 1999 (Table 6, Figure 5). It is noteworthy, however, that there were relatively few individuals from the various EPT taxa that were observed at the downstream sites in 2002. This is apparent from the percent EPT metric scores (Table 6, Figure 6). The percent EPT scores were lower at all three sites in 2002 than in 1998 and 1999, but the differences were much more dramatic at the downstream sites. Another interesting finding was the results of the Percent Dominant Taxon metric. At LR01 the score for this metric was very similar in 2002 to the score observed in previous years. However, at LR02 and LR03, this metric, which tends to increase with increasing perturbation, was much higher in 2002 than in 1998 or 1999 (Table 6, Figure 7). The dominant taxon at these sites in 2002 was the family chironomidae (Tables 3 and 4). Chironomids were occasionally the dominant taxon in the 1998 and 1999 samples, but they did not dominate the samples to the extent that they did in 2002. In most of the 1998 and 1999 samples various other taxa were dominant (e.g., *Isonychia*, *Stenonema*, *Epeorus*, *Macrostemum*)

and this changed throughout the year (see Reynolds and Young 2000). Another metric revealing increased perturbation downstream of the dam in 2002 compared to 1998 and 1999 was the Shannon Diversity index (Table 6, Figure 8). While the index was similar in 2002 at LR01 to previous years, it was much lower in 2002 at the downstream sites than in the either 1998 or 1999. The results of the other metric analyses were less definitive.

Conclusion

The benthic macroinvertebrate samples collected at two sites on the Lehigh River located between the mouth of Pine Run and the F.E. Walter Reservoir in 2002 indicated a general decline in community structure downstream of the dam compared to an upstream site located just downstream of the confluence of Tobyhanna Creek. This is consistent with the findings from sampling efforts conducted in 1998 and 1999 at these same sites (Reynolds and Young 2000). However, in 2002, the changes were generally more dramatic at the downstream sites than in previous years, especially when evaluated with such community metrics as the Hilsenhoff index, Percent EPT, Percent Dominant Taxon, and Shannon Diversity index. These metrics consistently demonstrated that the site nearest the dam (LR02) had the poorest benthic macroinvertebrate community and the site upstream of the dam (LR01) had the best. The most likely reason for the results that were observed in 2002 is the degraded water quality and precipitation of iron that occurred that year after the pool level was raised. Others studying the effects of the precipitation of iron on benthic macroinvertebrate communities have made similar observations (McKnight and Feder 1984, Gerhardt and Westermann 1995, and Koryak et al. 1972 as cited by Ashby 2002). The site nearest the dam was most severely affected by this phenomenon, and some recovery had occurred at the confluence of Pine Run. It is likely, however, that this was not the furthest extent of the degradation, as demonstrated by the unprecedented metric scores at site LR03 in 2002. We would recommend that careful attention be given to this matter in the coming years if the pool level is held at a higher level for drought relief and downstream flow augmentation.

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